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TITLE: A Novel Method for Determining Calcification Composition

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13. ABSTRACT ***(Maximum 200 Words)***

Calcifications can be divided into two broad categories. Type I are composed of weddellite (calcium oxalate dihydrate), while type II calcifications all have some phosphorus content, most typically calcium hydroxyapatite. Type II calcifications are known to be associated with carcinoma, while it is generally accepted that the exclusive finding of type I calcifications is indicative of benign lesions. We propose to develop a technique that will determine the composition of calcifications prior to biopsy, thereby allowing one to avoid biopsy on Type I calcifications. We believe that coherent scatter imaging (which is similar to x-ray diffraction imaging) may best determine the chemical composition of calcifications. In this grant, we propose to design a dedicated detector and optimize image acquisition. We will characterize the detector, and characterize specific raw materials to determine a basis set for compositional analysis. We will validate this design using a clinical trial of surgical biopsy specimens prior to histology. Finally, we propose to design a larger clinical trial designed to answer our main hypothesis, that Type I calcifications are exclusively benign, and hence do not require surgical resection.

14. SUBJECT TERMS
Cancer Diagnosis, Digital X-ray Imaging, Digital Mammography, Coherent Scatter Imaging, Microcalcifications, Elemental Composition

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Table of Contents

Introduction:

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Body:

The work for this grant was divided into six tasks. They are outlined as follows:

TASK 1: COHERENT SCATTER DETECTOR DEVELOPMENT (MONTHS 6-12)

- Design and construct the detector
- Modify as needed using data from Tasks 2 and 3

TASK 2: COMPUTER MODELING OF COHERENT SCATTER (MONTHS 1-18)

- Generate a monoenergetic model of the coherent scatter from the literature
- Combine to generate a polyenergetic model to study effect of spectrum on scatter
- Add effects of pencil beam size, and finite object size to study effect on scatter
- Develop initial methods of separating data into basis sets
- Add issues related to SNR and dose to optimize detector design and operating conditions

TASK 3: DETECTOR CHARACTERIZATION (MONTHS 12-24)

- Characterize the detector in terms of imaging parameters linearity, MTF, NPS, NEQ, and DQE
- Use these data to optimize detector design

TASK 4: PHANTOM STUDIES – BASIS SET DETERMINATION (MONTHS 18-30)

- Characterize the detector in terms of basis materials, including linearity.
- Develop a basis set of materials (calcifications, adipose, glandular, etc.)
- Characterize the detector in its ability to distinguish admixtures of materials.

- Develop beam hardening and other corrections as needed to make system accurately report data that are linear in terms of the basis materials.

TASK 5: SPECIMEN STUDY (MONTHS 18-36)

- Recruit 100 patients scheduled for surgery on the basis of breast calcifications
- Image the surgical specimens prior to biopsy
- Analyze data and correlate pathology results with compositional analysis

TASK 6: *IN VIVO* IMAGING FEASIBILITY STUDY DESIGN (MONTHS 30-36)

- Perform calculations on the feasibility of *in vivo* imaging, including dose.
- Use those data derived in Task 5 to estimate the statistical properties of this test (e.g. Type I calcification prevalence, specificity and sensitivity of composition characterization ,etc.)
- Use these data to design larger multi-center clinical trial to definitively determine the correlation between Type I calcifications and benign disease.

The work was supposed to commence on July 1, 2000. However, the grant called for the majority of the work to be completed by a graduate student. It was our intention to use the stipend and tuition budget items to help this graduate student. Unfortunately, due to circumstances beyond the control of the PI, the intended graduate program did not begin in January 2000, as was originally expected. For much of 2000 and 2001, the fate of the medical physics graduate program at Thomas Jefferson University has been uncertain.

We delayed the start of the research, funded by this grant, under the belief that the research would commence when the graduate program was approved and a graduate student hired. However, due to continued delays in the start of the graduate program, we have now decided that we can not further delay work on this grant. Under approval of the DOD, we delayed the start of the grant until June 1, 2001. We furthered delayed the grant by one month (to July 1, 2001) to coordinate the commencement of the grant with the completion of other research. Since July 1, 2001, Dr. Andrew Maidment (PI) and Dr. Micheal Albert (Research Associate) have been working on the grant. We are currently preparing a request for rebudgeting to formally allow us to remove the graduate student stipend and tuition from the budget and substitute Dr. Albert's salary. This request will be sent to the DOD under separate cover.

Key Research Accomplishments:

As a result of these delays, no progress occurred between July 1, 2000 and June 30, 2001. Since July 1, 2001, we have been working on assembling the experimental apparatus and have begun designing the experiments to be performed in Tasks 1 and 2 of the Statement of Work.

Reportable Outcomes:

None to date.

Conclusions:

The start of the grant was delayed one year. Thus, at the completion of this first year, there are few research accomplishments, and no reportable outcomes.

References:

None.

Appendices:

None.